Management of Spent fuel from PHWRs in India– An Integrated approach

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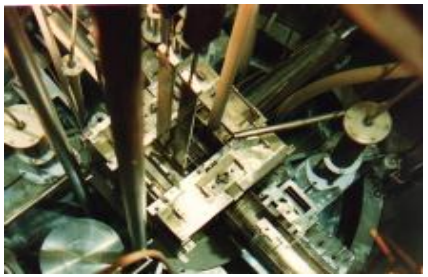
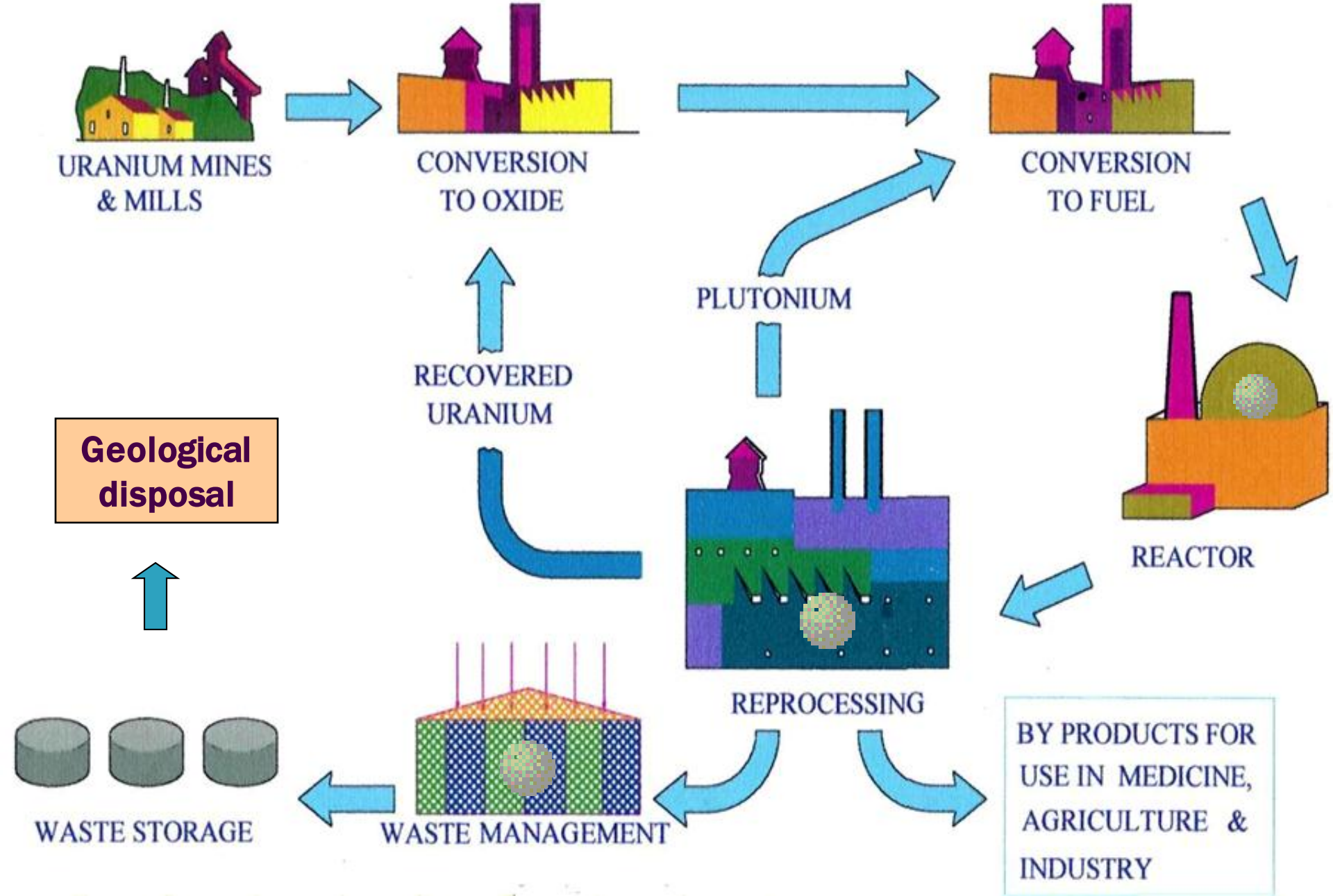
Three stages of Indian Nuclear Energy Programme

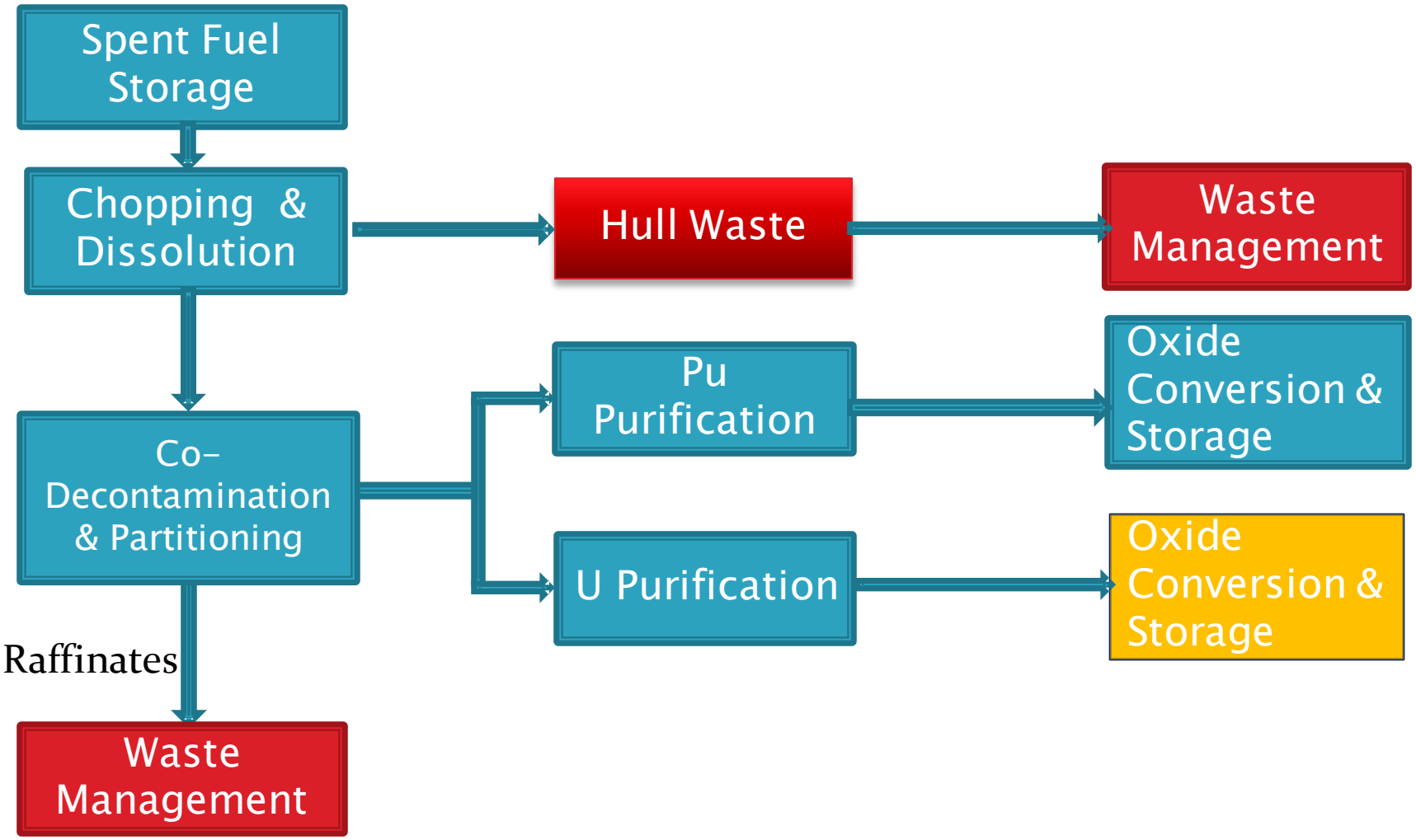


In the Indian context closed fuel cycle approach is the best option

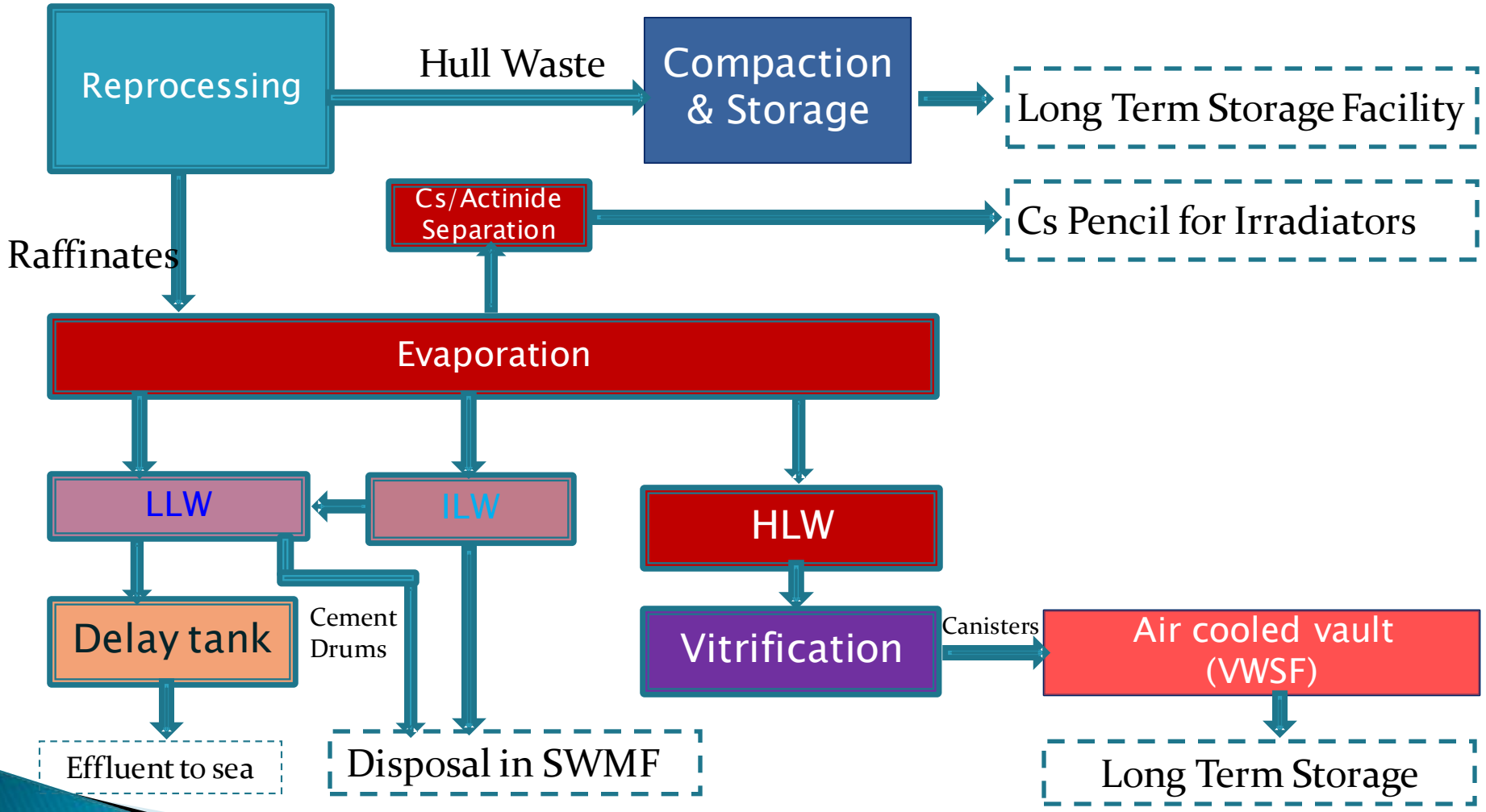
NUCLEAR FUEL CYCLE



Flow Sheet of Recycling

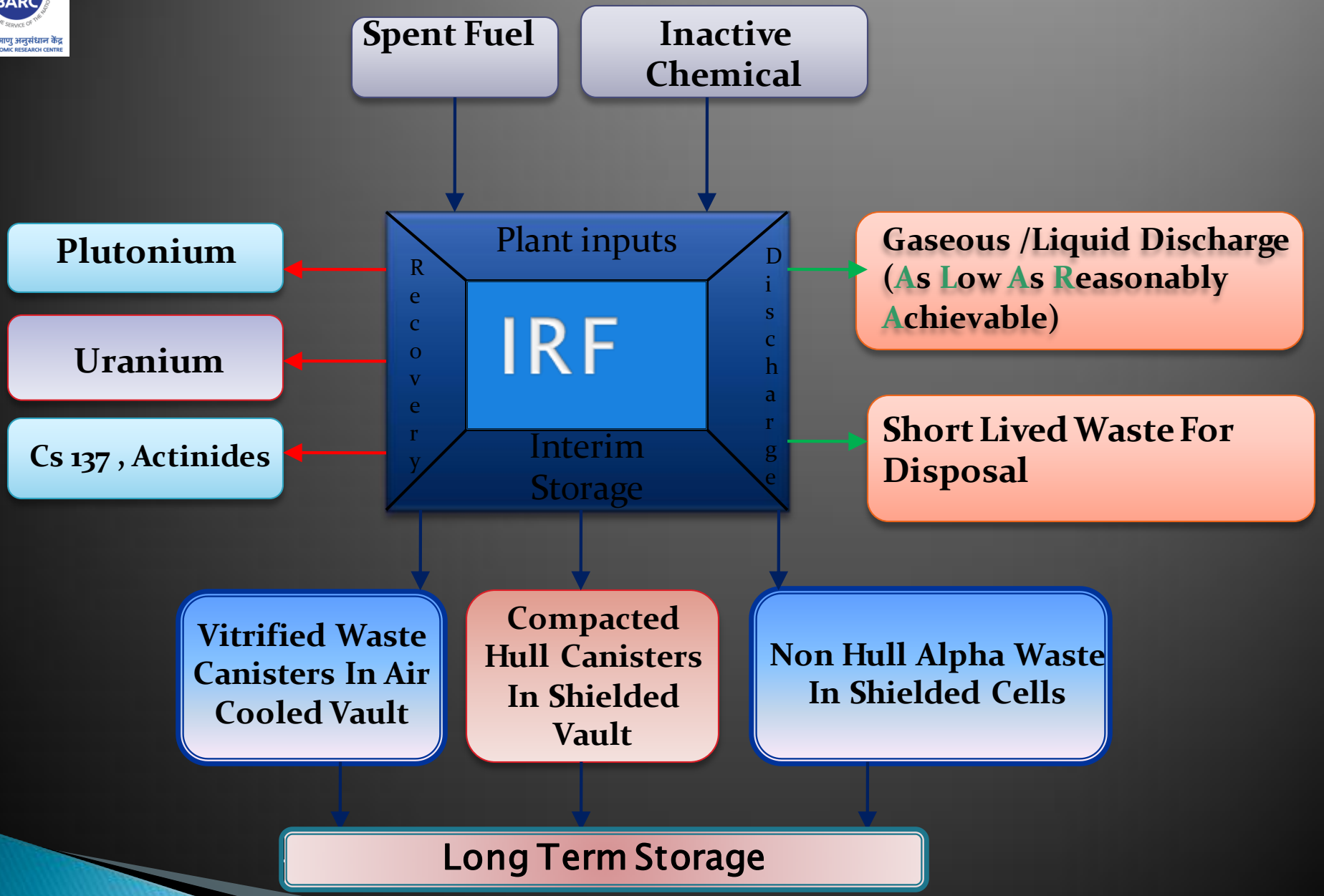


Waste Management

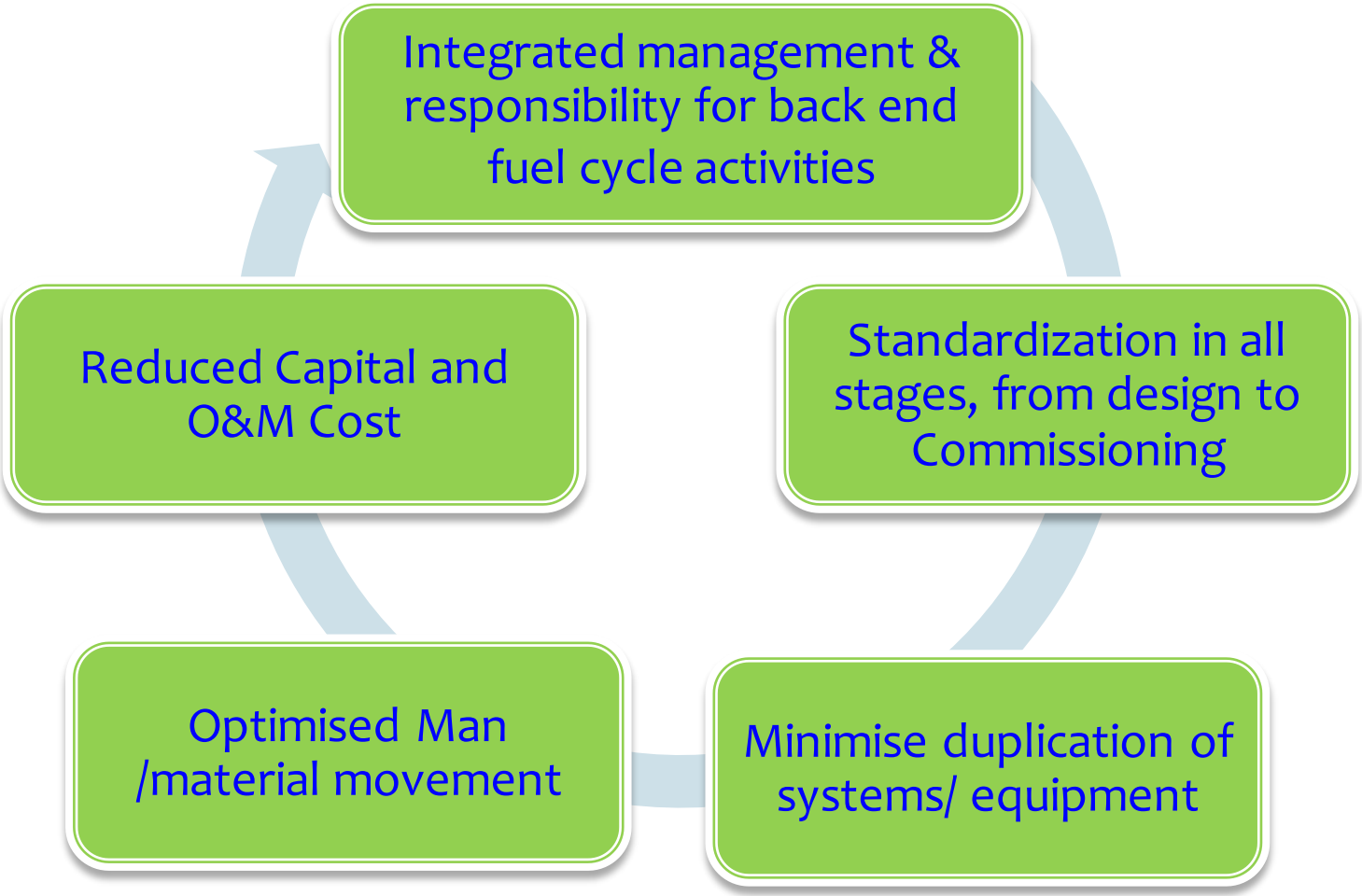


Objective of An Integrated Recycle Facility(IRF)

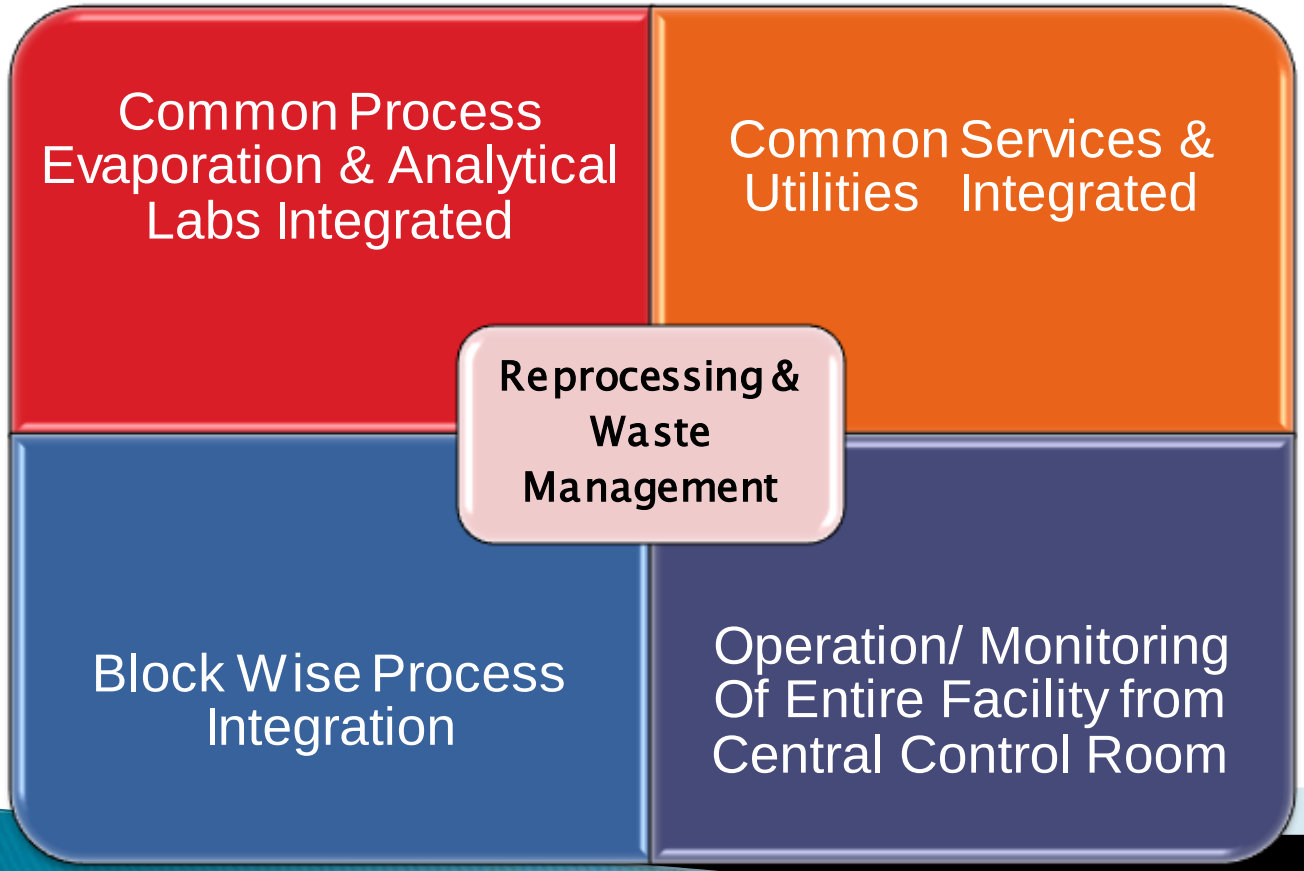
- Works on solid-in solid-out concept
- Designed to Recycle spent fuel from Pressurized Heavy Water Reactors (PHWRs) (220 & 540 MWe).
- Depleted Uranium and Plutonium from these plants will be supplied for FBRs and Advanced Heavy Water Reactor Programme


Spent Fuel
Inactive Chemical
Plant inputs
Recovery
IRF
Interim Storage
Discharge
Plutonium
Uranium
Cs 137 , Actinides
Gaseous /Liquid Discharge (As Low As Reasonably Achievable)
Short Lived Waste For Disposal
Vitrified Waste Canisters In Air Cooled Vault
Compacted Hull Canisters In Shielded Vault
Non Hull Alpha Waste In Shielded Cells
Long Term Storage

Objectives of Integration



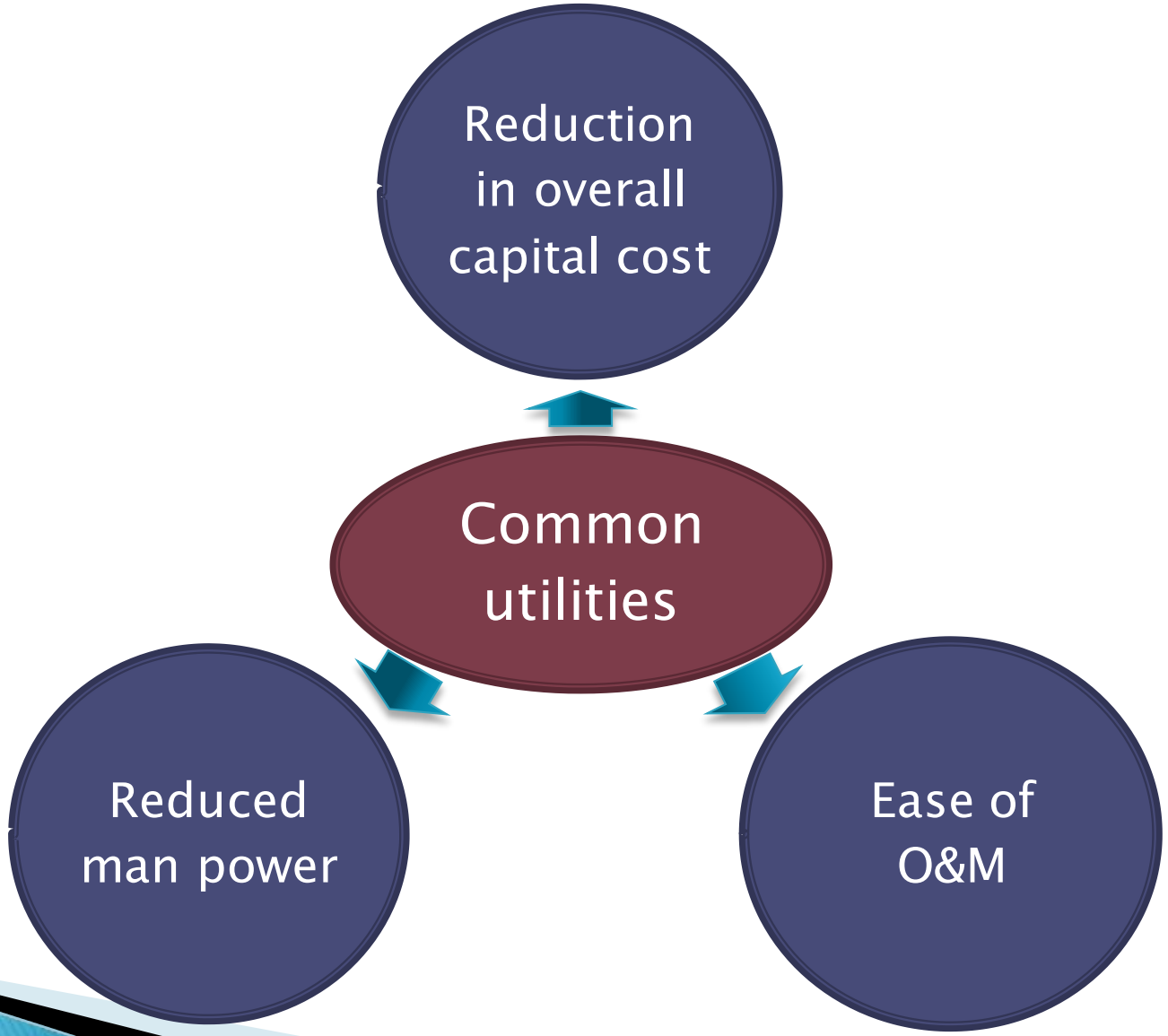
INTEGRATION



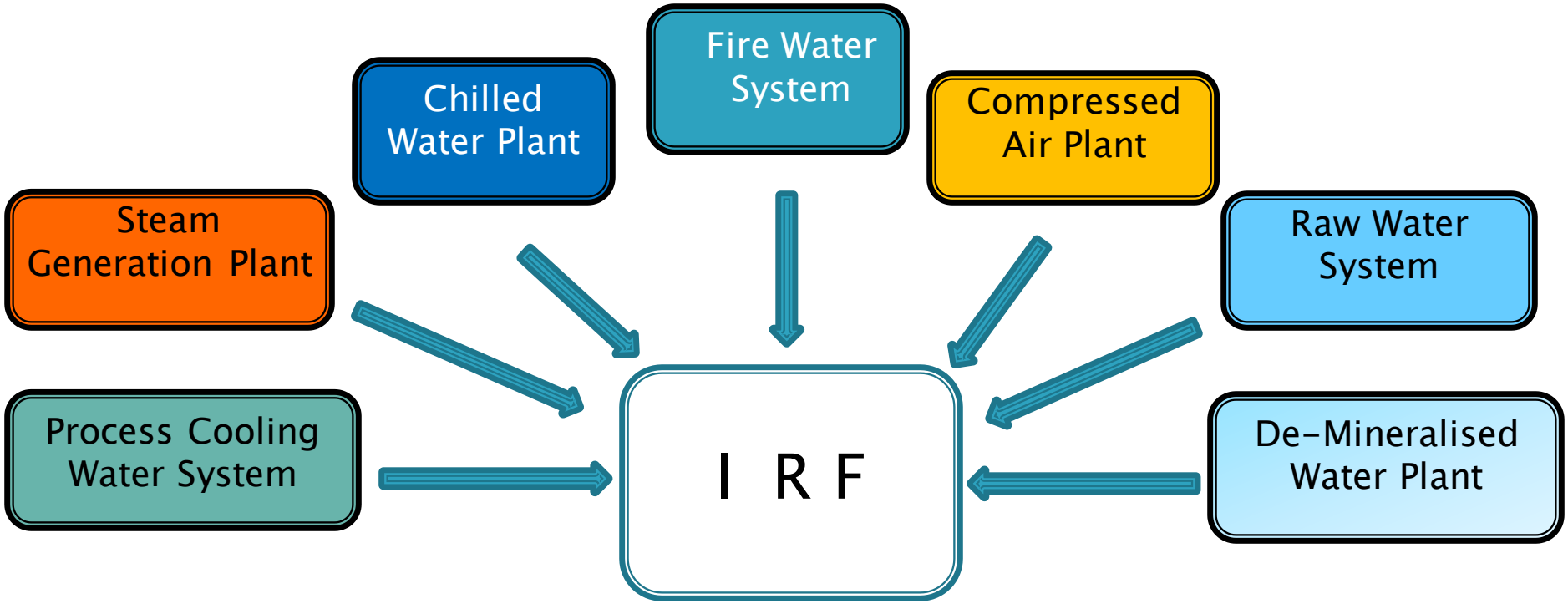
Main Blocks concept

- Spent Fuel Storage Block
- Process Block
- Evaporation & Storage Block
- Control & Reconversion
- Vitrification Block
- Control Room Block
- Nuclear Material Storage
- Vitrified Waste Storage
- Hull Compaction & Storage
- Utility & Services Block

Utilities–Benefits

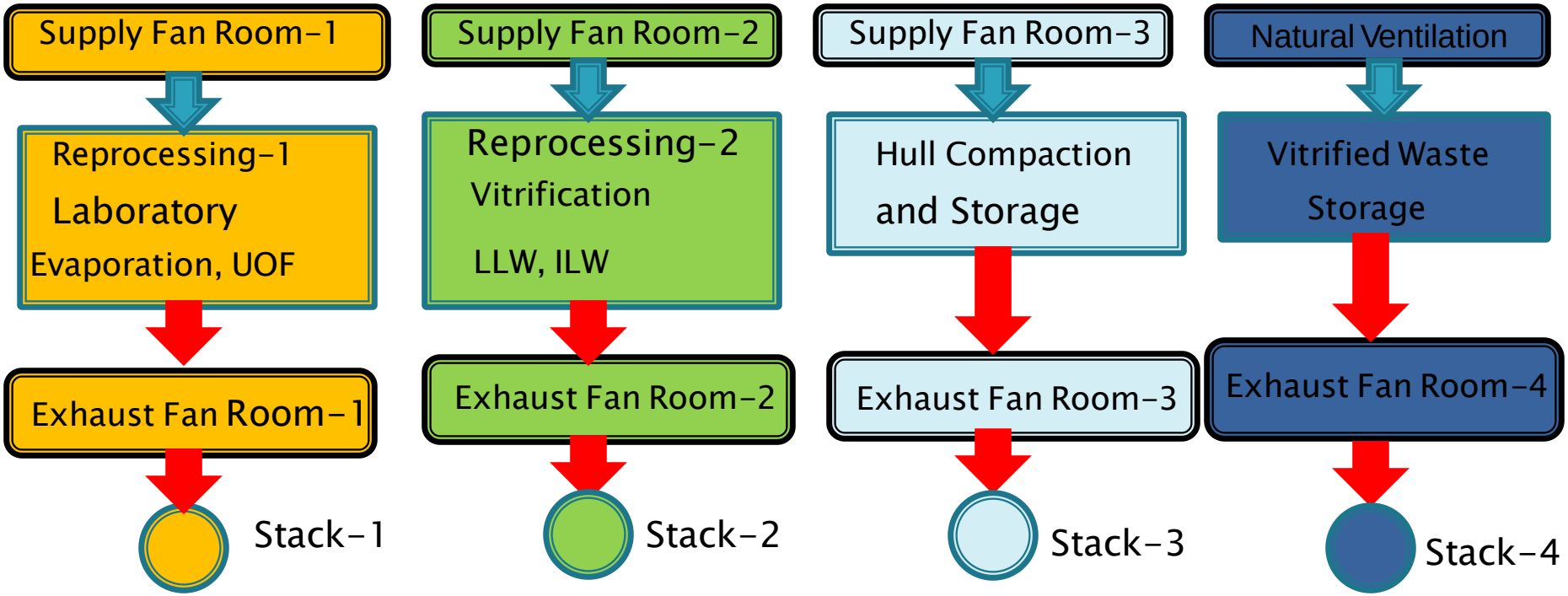


Utilities contd....



- Steam condensate recovery and reuse – Reduce water consumption
- Energy conservation concepts adopted

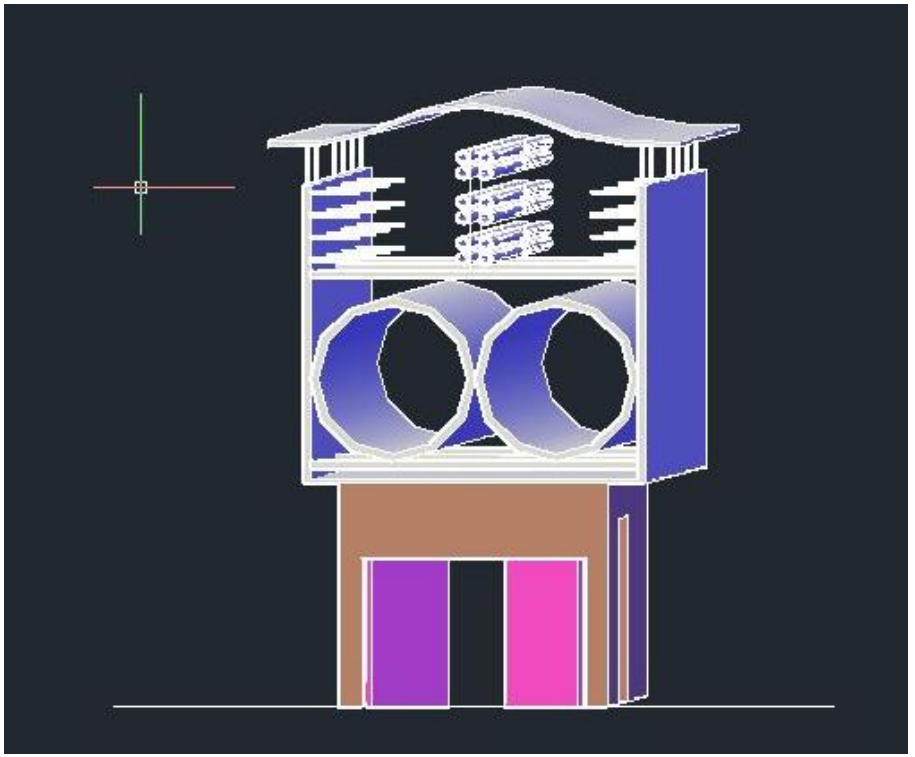
Ventilation system



- Centralized supply & exhaust air blocks
- Dedicated Exhaust filter banks in each block
- Standardization of equipment for ease of O&M

Segregation of Services Lines

- A two tier Personnel cum service corridor connects all process blocks and will carry about 25 services lines



I&C Systems

Integrated Main Control Room For All Process Blocks.

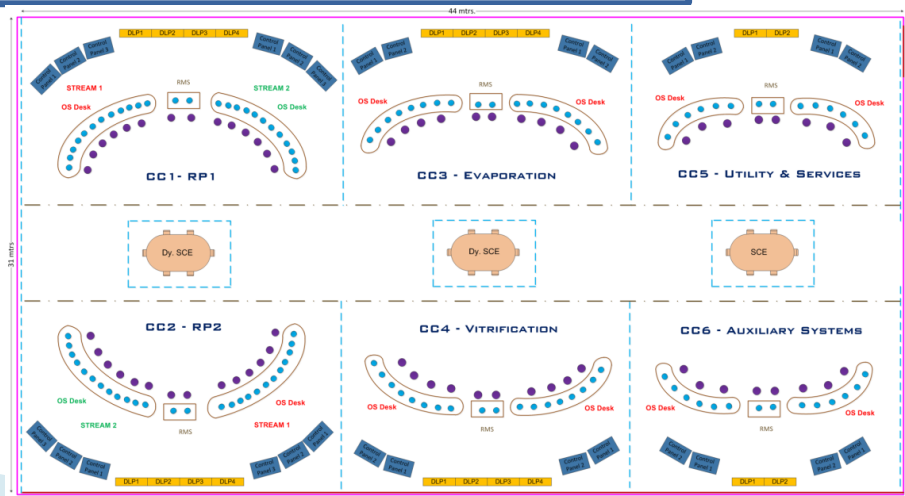
Six Control Centers In One Control Room.

- Radiation Monitoring Systems Integrated With I&C

Secondary Control Room For Initial Commissioning And Back Up Requirements.

- 25,000 Input/Outputs PLC/SCADA

Provision For Online Monitoring And Diagnostics Of I&C Systems



Spent Fuel Storage

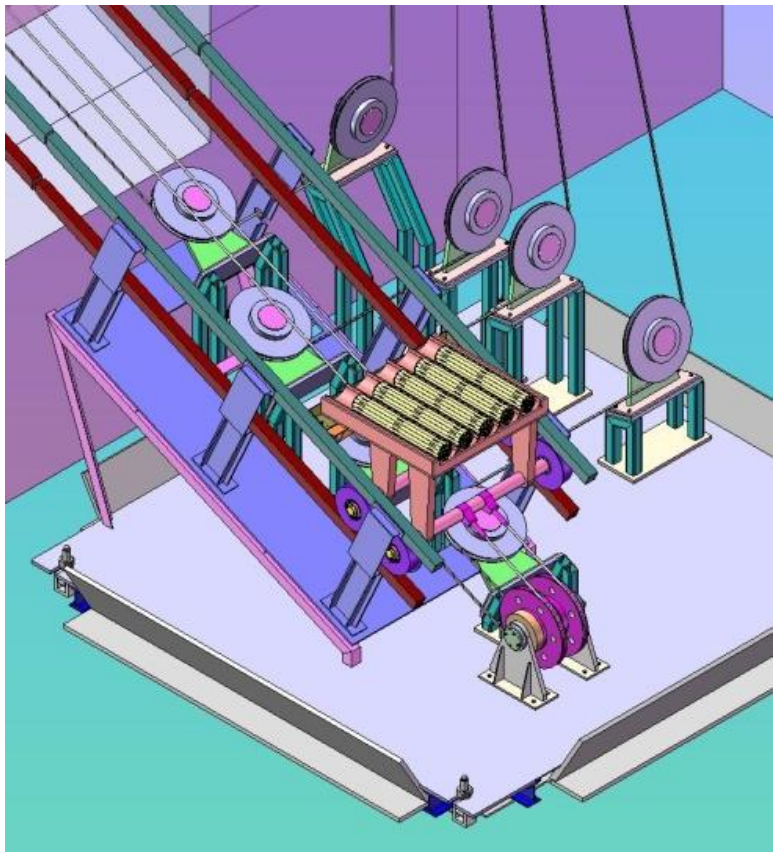
- Wet Storage concept followed
- Minimum 3 year cooled fuel from PHWRs
- Provided with safety systems like
  - Pool water cooling system
  - Pool water polishing system
  - Single failure proof EOT Crane
  - Ventillation system
  - Infiltration Gallery
  - Leak collection and Detection system
  - Pool water level, Temp and Radiation monitoring system

Spent Fuel Storage Contd.

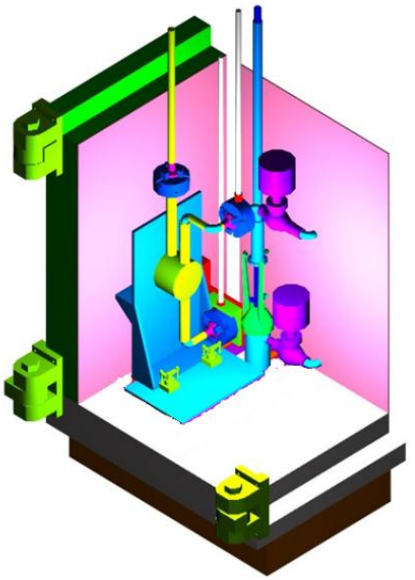
- The spent fuel storage tray stack is qualified for seismic stability
- The EOT cranes and Pool Bridge have anti toppling lugs and are qualified under DBE
- Ground water table is maintained below raft of pool by an Infiltration system
- The cooling system is functional under external event and has dedicated Class –III power supply
- Additional water filling provision given in event of extended power outages.
- Provision for handling and storage of failed fuel bundles

New Technologies being implemented

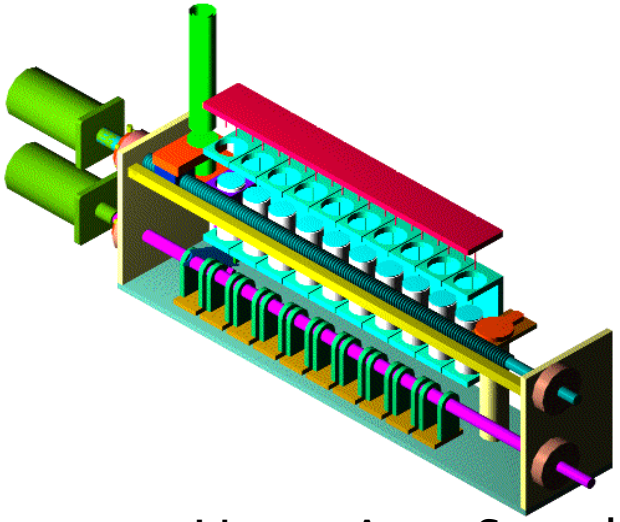
- Automation in Fuel Transfer (DFTS)
- Common Multiple (gang) type Spent Fuel Chopper (SFC) for both types (37 pin and 19 pin) fuel bundle
- Linear Auto Sampler (LAS) for automated sampling
- Remote Maintenance device for metering pumps
- Hull compaction for volume reduction and assaying
- Cs removal and production of Cs pencil source
- Extensive use of Power Manipulators and remote devices
- Improved Material of Construction



Direct Fuel Transfer System



Remote Pump Maintenance

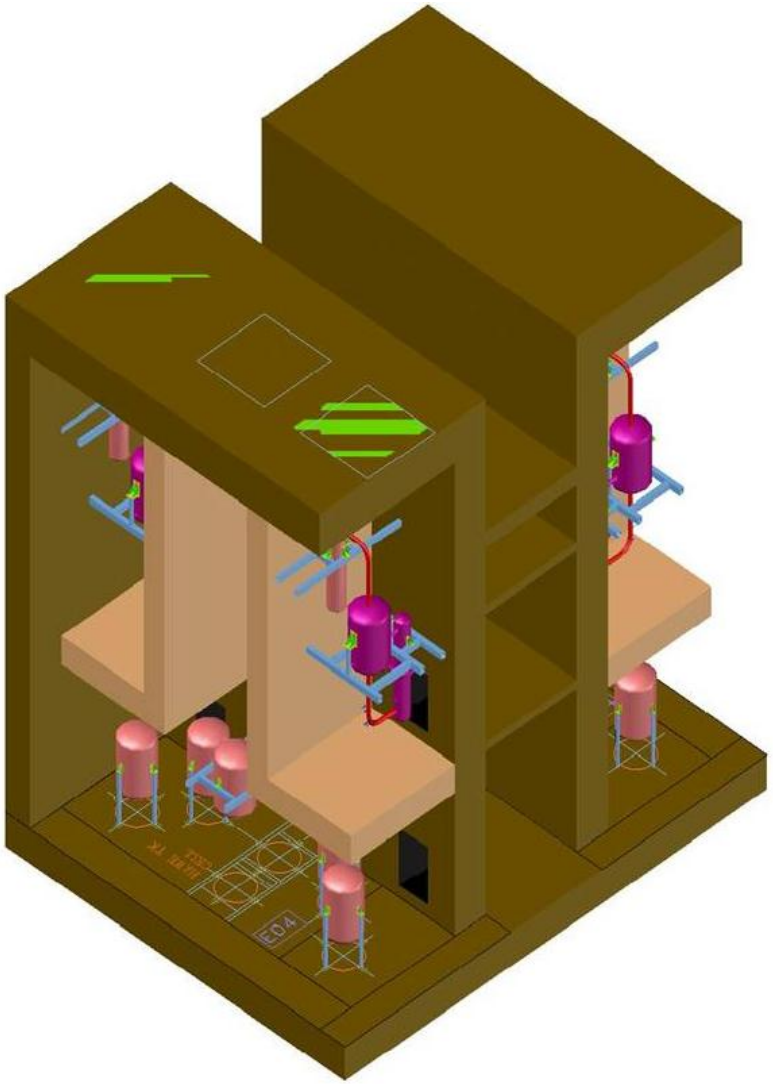


Linear Auto Sampler

Main Waste Management Blocks

- Waste Evaporation Block
- Vitrification Block
- Vitrified Waste Storage Block
- LLW, ILW & OLW Blocks
- Hull Compaction & Storage Block

Waste Evaporation



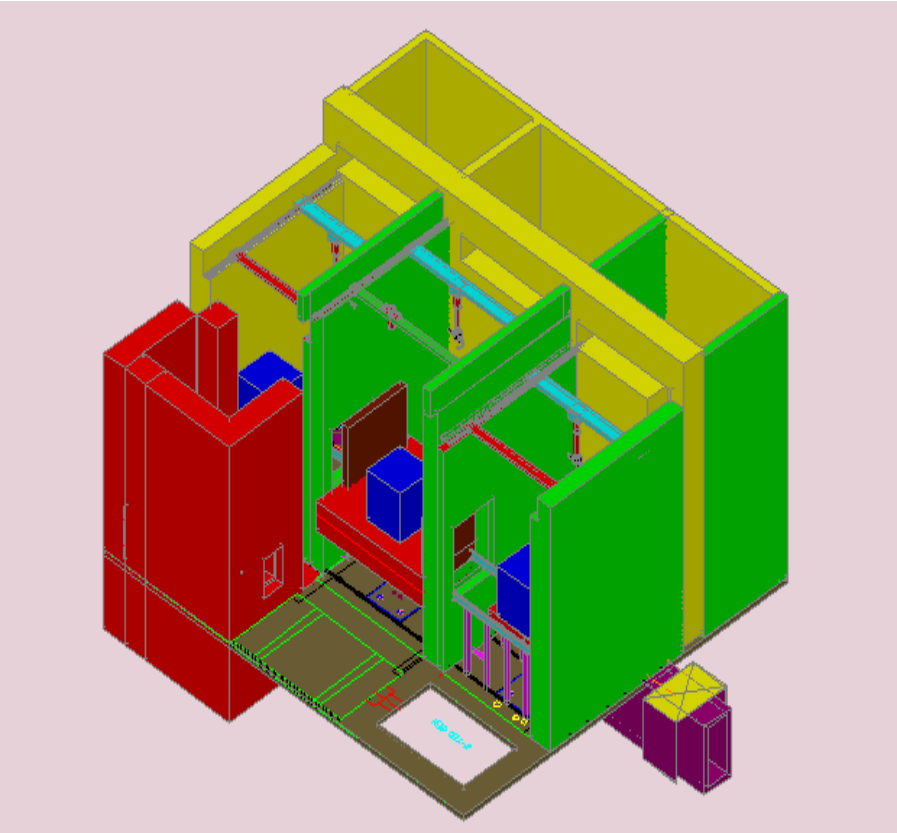
- A Centralized facility for waste evaporation and storage.
- Has Sub-cells for TSEs with provision of replacement with minimum downtime.

This block also houses following Processes

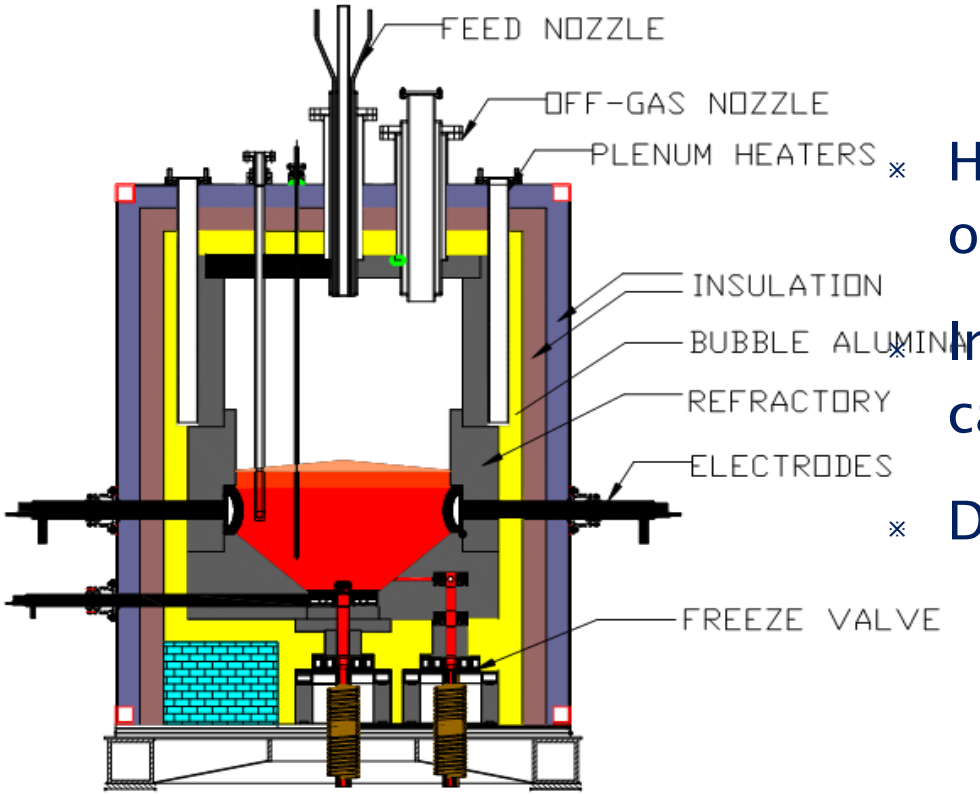
- U Separation for more oxide loading in vitrification
- Provision for separation of Cs and Actinides for effective waste management

Vitrification

- Vitrification by Two Independent JHCM Systems, each having 100% capacity
- Dedicated common Decommissioning Cell
- Roll-in & Roll-out concept for Melter replacement



Vitrification contd..

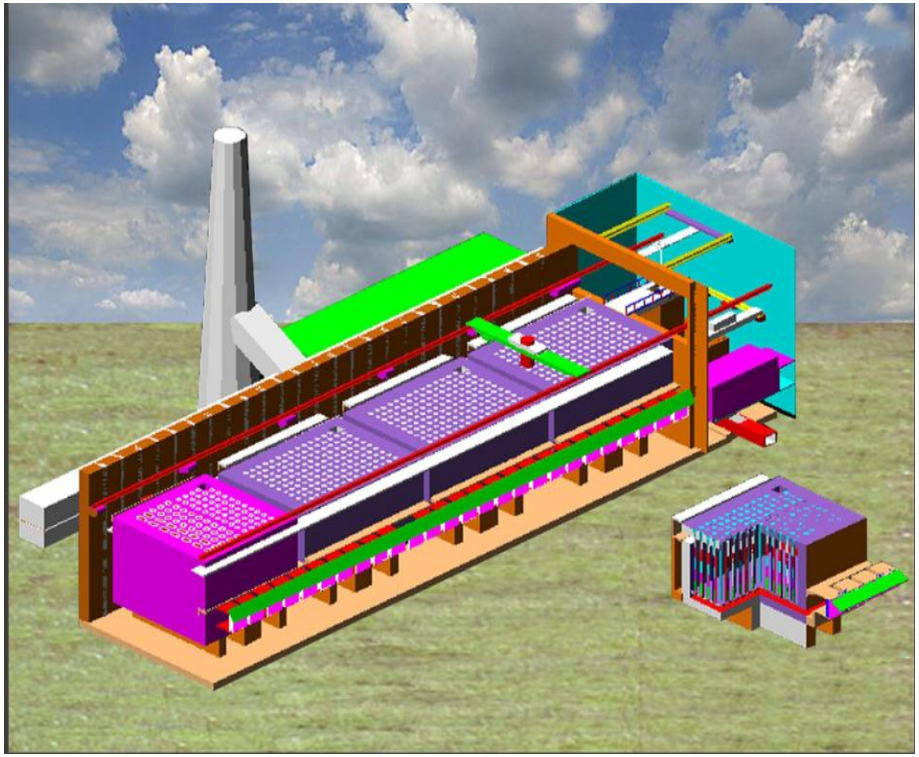


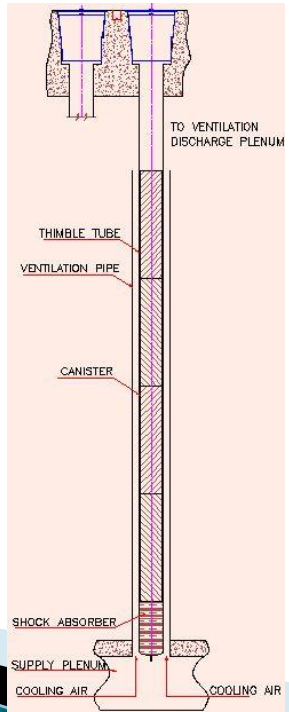
SCHEMATIC DIAGRAM OF JOULE HEATED CERAMIC MELTER

- High capacity melter for vitrification of HLW
- Immobilisation of higher activity per canister
- Designed for remote replacement

Vitrified Waste Storage

- Stacking of four canisters in each thimble tube
- Stack assisted natural convection cooling
- Provision for HEPA filtration





Hull Compaction

- The facility has been designed for the first time in India and Facilitates Remote operation & maintenance
- Large hull volume from high capacity plant necessitates compaction of hull wastes
- Volume reduction factor achieved is 5 by using 2000 Te Supercompactor

TEST SET UP

SIMULATED HULL PIECES

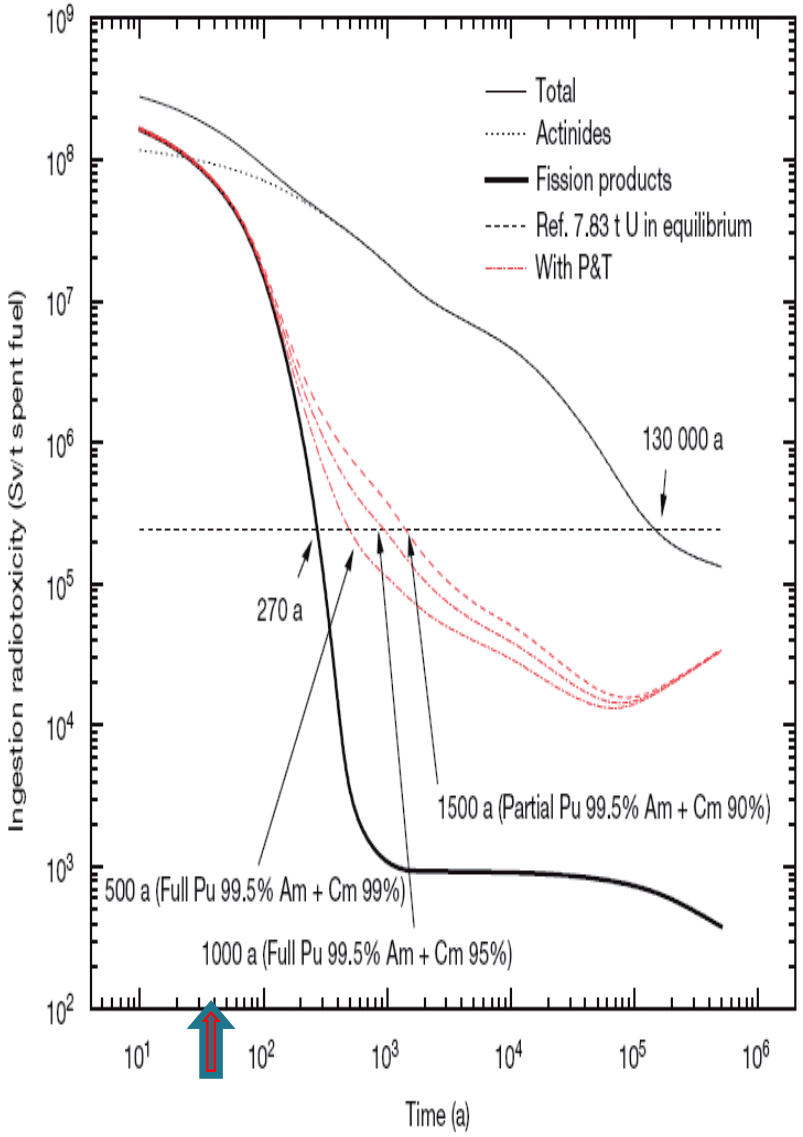
COMPACTION IN PROGRESS

COMPACTED DISC (PUCK)

Recent Developments in Waste Management

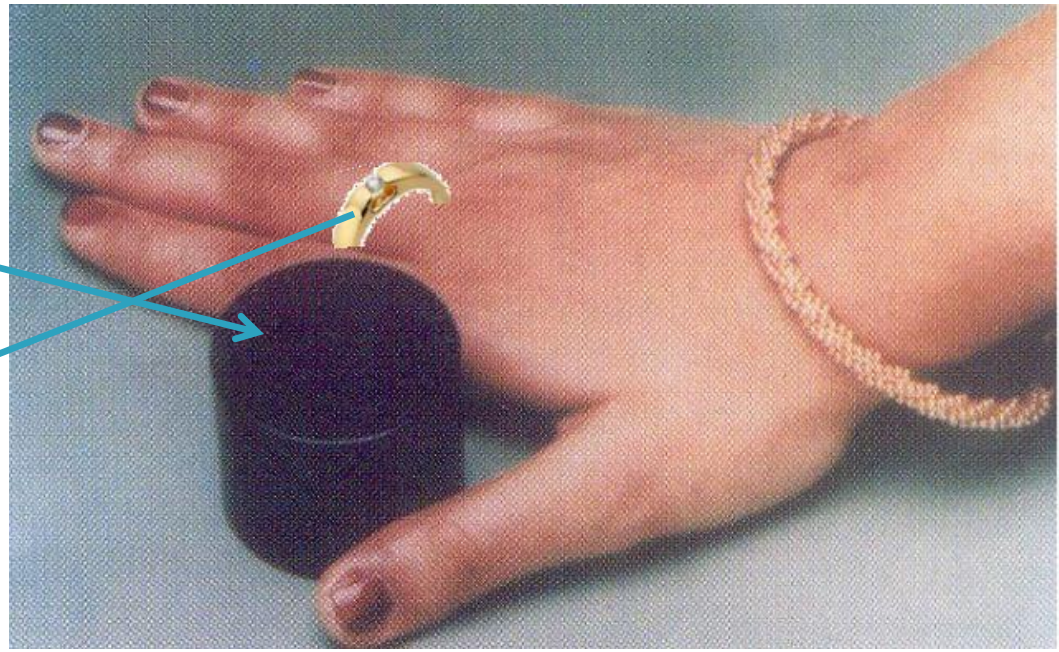
- **Novel Solvents have been Developed for minimisation of long term radio toxicity of the waste by following 3-major steps.**

1) Separation of residual U & Pu from HLW
2) Seperation of fission products like Cs & Sr
3) Bulk separation of trivalent actinides along with lanthanides from U lean HLW



OVERALL SOCIETAL BENEFITS OF WASTE REDUCTION

- Volume of High Level Vitrified waste generated for power consumption of an average family for entire life
- Volume of waste if actinide is also separated from HLW




THANK YOU